AEROSPACE RECOMMENDED PRACTICE
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Revised

GAS TURBINE ENGINE TRANSIENT PERFORMANCE PRESENTATION FOR DIGITAL COMPUTER PROGRAMS

TABLE OF CONTENTS

1. PURPOSE

1.1 This Aerospace Recommended Practice provides a method for the presentation of gas turbine engine transient performance as calculated by means of digital computer programs, and is compatible with ARP 681, "Gas Turbine Engine Steady State Performance Presentation for Digital Computer Programs."

1.2 The intent of this Recommended Practice is to facilitate calculations by the program user without unduly restricting the method of calculation used by the program supplier.

2. GENERAL REQUIREMENTS

2.1 General Engine Description: A general description of the engine will be provided. This description will include the type of engine, engine configuration, engine control characteristics, and other characteristics that are necessary to understand the performance and operation of the engine represented by the computer program. Examples are: thrust or power class, airflow, pressure ratios, airbleed stations, nozzle type, bypass ratio, and method of thrust augmentation.

2.2 General Program Requirements: The transient program is intended to provide simulation of engine response to input variables with an equivalent sine wave frequency content of up to approximately 30 hertz. Although programs can be constructed to respond to much higher frequencies there is insufficient practice at this time to establish procedures in this area.

2.3 Program Operation

2.3.1 The program shall be supplied in a form readily adaptable to the user's computer. Provision for operating the program on more than one computer type should be individually coordinated between user and supplier.

2.3.2 The program will have the capability of functioning both as a subroutine and as an independent program.

2.4 User's Manual

2.4.1 The program supplier will deliver the User's Manual with the program.

2.4.2 The following format and content are recommended for the User's Manual.

1. Introduction

2. Table of Contents

3. Engine Description: This section should enable the user to identify the engine and its general characteristics.

4. Program Description: This section should enable the user to identify the computer equipment and programming practices upon which the program relies.

5. Nomenclature: This section should include program variable names, station designations and other information required to understand the User's Manual.

6. Program Set-Up: This section should include instructions and information to enable the program user's computer staff to set-up the program. This should include an overall program structure block diagram and sufficient information to understand the overlay program structure, if applicable. A flow chart of a user calling program is included as Appendix A.

7. Engine Performance Options: This section should describe the interfaces, options, limitations and other features that enable the user to fully understand the capability of the program.

8. Input/Output: This section should describe all program inputs and outputs in sufficient detail to avoid ambiguity and should list the units of all input and output parameters.

9. Program Messages: This section should explain the messages produced during program operation and identify the numerical status indicator codes.

10. Listings: This section should contain FORTRAN listings of the MAIN program and of the input and output FORTRAN statements utilized directly by the MAIN program.

11. Test Cases: This section should describe the test cases that the supplier provides for program checkout by the user. All test case printouts will be supplied with the computer program, or in the user's manual.

12. Identification and Revision Procedure

13. References

2.5 Program Scope: Transient engine performance computer programs will be the primary source for time-dependent variations of engine performance. Steady-state engine performance computer programs will be the primary source for steady-state engine performance. Transient engine performance calculations will be based on one of three steady-state performance categories: preliminary design, status, or specification.

2.5.1 Limits: All known limits will be defined in the User's Manual. When the input calls for an operating point outside limits, the program will proceed to complete its calculation, if possible, and output the appropriate status indicator. The status indicator should clearly define the validity of the output. The program will always be capable of continuing with the next transient case provided the user's computer operating system does not override this capability.

2.5.1.1 Limits are divided into three categories as follows:

1. Engine limits as used herein are those limits that are not automatically applied by the engine control or precluded by the engine design, e.g., maximum temperature limit if automatic over-temperature control is not provided and pilot action is necessary.

2. Environmental operating limits are defined by the operating envelope of inlet temperature and pressure; or equivalent altitude, free stream Mach number, ram recovery and atmospheric conditions.

3. Program limits are those which define the bounds within which the program will function and will adequately simulate the engine. Program limits should exceed corresponding engine limits, but preliminary design programs may be incomplete because component definition is inadequate.

2.5.2 Consistency: Consistency herein means the agreement between transient program output of steady-state conditions and steady-state program output for the engine or group of engines represented. Transient and steady-state program requirement differences can cause program output differences. At all power settings higher than 30% of maximum nonaugmented power the transient performance program gross thrust, shaft power, total fuel flow and airflow output should agree with that of the corresponding steady-state performance program output within ± 3 percent. Different consistency requirements shall be coordinated between user and supplier.

2.5.3 Prediction Capability: When requested by the user, the program supplier will furnish estimates of the expected agreement between the engine transient program predictions and the engine transient performance at selected conditions.

3. PROGRAMMING PRACTICES

3.1 Computer Capabilities: Normally an engine transient performance program will require at least 40,000 32 bit words of core storage. Execution time will be dependent on memory cycle time, the complexity of the engine simulation, and the frequency range of the problem being investigated with the program. Requests for programs on computers with lesser capabilities must be individually coordinated.

3.1.1 The frequency effects normally studied with engine transient programs range from 0 to 5 hertz. For computers having a one microsecond cycle time, execution times of approximately 10 times real time can be expected for simple engine configurations. Transient studies using complex engine configurations dealing with effects in the neighborhood of 30 hertz may require execution times of 1000 times real time.

3.2 Program Language: Engine computer programs will use as a minimum the American National Standards Institute X3.9 FORTRAN language. This language may be augmented by features found in the commonly used FORTRAN languages of industry when these features are known to be acceptable to the program users.

3.3 Precision: Hardware and software differences among computers can cause small differences in performance output from otherwise identical programs. Differences from supplied test cases smaller than ±0.25 percent should be considered normal for the initial value point. Differences smaller than ±1.0 percent at a given output time should be considered normal for transients of 10 seconds or less real time.

3.4 Station Designation: The following station designation system will be used to identify the points in the gas flow path that are significant to engine performance definition.

3.4.1 The system provides for the consistent definition of the process being undergone by the gas, regardless of the type of engine cycle. The five main processes isolated are: air intake, compression in engine compressors, heat addition, expansion in turbines, and expansion in a nozzle.

3.4.2 The station designations required to identify the five processes for the primary gas flow are:

0. Free stream air conditions
1. Inlet/engine interface
2. First compressor front face
3. Last compressor discharge
4. Burner discharge
5. Last turbine discharge
6. Available for mixer, afterburner, etc.
7. Engine/exhaust nozzle interface
8. Exhaust nozzle throat
9. Exhaust nozzle discharge

3.4.3 Extension of the primary flow designation scheme to the bypass flow is obtained by prefixing a digit to the numbers in Paragraph 3.4.2. Unity (1) will be used for the innermost bypass duct.

Examples

12. First compressor front face tip section (if different from Station 2)
13. End of compression of bypass flow
17. Bypass duct/exhaust nozzle interface

18. Bypass exhaust nozzle throat

3.4.4 Ejector nozzles will be considered to be a special case of a bypass duct and the digit 9 prefixed. For example, 92 will designate the ejector inlet.

3.4.5 Decimal or alphanumeric subdivision will be used for output identification of intermediate stations. If no ambiguity is possible, the decimal point may be omitted.

3.4.6 Figures 1 and 2 in Appendix B illustrate the application of this system to several typical engine configurations.

3.5 Nomenclature: The following list of letters will be used to begin the FORTRAN name of program variables (unless otherwise noted).

A	Geometric area
AE	Effective area
ALT	Altitude
BPR	Bypass ratio
C	Coefficient
D (imbedded)	Difference
DIST	Distortion
ETA	Efficiency
F	Force (thrust)
FAR	Fuel air ratio
FMAX	Maximum subroutine response frequency
FHV	Fuel heating value
GM	Mass
H	Enthalpy
HP	Power
P	Total pressure
PC	Power code
PLA	Power lever angle
PS	Static pressure
Q (leading)	Heat flux
Q (imbedded)	Ratio
R (trailing)	Referred (corrected)
S	Entropy
SETAR	Ram recovery selection
SFC	Specific fuel consumption

SHP	Shaft power
SIM	Inlet mode selection
SM	Stability margin
T	Total temperature
TIME	Time from start of transient (real time not computer time)
TRQ	Torque
TS	Static temperature
U (trailing)	Derivative with respect to time
U (imbedded)	Derivative with respect to the variable following it
V	Velocity
VOL	Volume
W	Flow rate
WA	Air flow rate
WB	Bleed flow rate
WF	Fuel flow rate
X	Used to insure that the variable is treated as a real rather than an integer number
XJ	Polar moment of inertia
XM	Mach number (free stream unless followed by station designation)
XN	Shaft rotational speed
Z	Any name of a variable that is used in the input as well as in the output must be prefixed with a Z on the output name. If X is used as a prefix in the name of the variable (e.g. XM) then it is dropped in favor of the Z when used in the output (e.g. ZM).

Most variables will require the addition of a station designation to complete the description. Examples:

Total pressure at station 3	P3
Total pressure ratio, station 4 divided by station 3	P4Q3
Static pressure ratio, station 4 divided by station 3	PS4QS3
Total pressure change from station 6 to station 7	P6D7
Time rate of change of total pressure at station 3	P3U
Rate of change of total temperature at station 2 with respect to high pressure compressor rotor speed	T2UNH

Most computers are limited to either five or six characters per parameter name. When this limitation is not compatible with the foregoing system of nomenclature the parameter name abbreviations to be used will be determined by the program supplier and defined in the appropriate section of the User's Manual.

3.6 Power Definition

3.6.1 One of the inputs to the transient program will be power lever angle or its equivalent, power code. The power code (PC) is intended to represent and, when known, should be replaced by power lever angle (PLA).

3.6.2 Power Codes are defined as follows:

Power Code	Definition
100.0 to 60.0	Maximum augmented to Minimum augmented
50.0 to 20.0	Maximum non-augmented to Ground Idle
15.0 to 5.0	Idle Reverse to Maximum reverse
1.0	Windmilling

3.7 Standard Atmosphere: The atmosphere to be used for engine performance determination will be the United States Standard Atmosphere, 1962, geopotential pressure altitude. (Identical with ISO Standard Atmosphere up to 50000 metres).

3.8 Programming Standards

3.8.1 The highest level of compiler optimization operationally available to the program supplier should be used.

3.8.2 The program supplier will provide automatic preventive action for the following illegal arithmetic operations or processes; the square root of a negative number, illegal arguments to exponential, logarithmic and inverse trigonometric subroutines. In this event a status indicator will be provided and the program will always be capable of continuing with the next transient case.

3.8.3 The engine simulation program, while operating in the subroutine mode (see paragraph 2.3) shall be available as one subroutine call rather than separate calls to a collection of subroutines which, when taken in combination, represent the engine.

4. PROGRAM CAPABILITIES

Program provisions for the effects described in this section will be included when they are applicable. Coordination of these program capabilities between user and supplier is particularly important in transient programs since core storage and running time can be limiting factors in the use of the program.

4.1 Time Interval Control

4.1.1 A single input, TIME, will be used to inform the engine subroutine of the value of time at which it is next to return control to the calling program. In addition, control will be returned when certain values of the Numerical Status Indicators have been created (see paragraph 5.5). Engine subroutine output data will be available at each return.

4.1.2 A steady state solution providing initial conditions for the transient will be generated whenever TIME is zero.

4.1.3 Within one transient case the engine subroutine shall be capable of generating output at only those values of TIME that are equal to or greater than the previous value. If not required by the user the capability of repeated entries at equal TIME values may be omitted.

4.1.4 The engine subroutine may internally select its own computational time step and may generate output by interpolation or extrapolation.

4.1.5 The user will supply as input a frequency above which he will not require accurate response. The engine subroutine will contain logic to ensure that a time step is selected which is adequate for the frequency supplied by the user. The input frequency shall be capable of being changed from an initial value (FMAXP) to a secondary value (FMAXS) and back, once during the transient.

4.1.6 Failure of the engine subroutine to converge can be caused by severe ramps or step changes of input. If such changes are anticipated, co-ordination between program user and supplier is essential.

4.2 Variable Input

4.2.1 When it is necessary for the program user to vary an input parameter with time (e.g. intake temperature versus time), this capability will be provided by the user.

4.2.2 Provision to schedule an input parameter against internal engine parameters (e.g. distortion parameters versus intake mass flow, power take-off versus shaft speed) shall be made by the program user where needed. The program user will obtain those internal engine parameters required for his calculations from the engine subroutine output.

4.2.3 It may be necessary for the user to obtain accurate engine subroutine output by iteration between user program and engine subroutine. (In this case, repeated input to the engine subroutine of the same value of TIME will be required, until convergence of the iteration is achieved.) If not required by the program user the capability of repeated entries with equal TIME values may be omitted. The iteration procedure may lead to unacceptable computation times and it may be satisfactory for the user to take engine subroutine output from the previous value of TIME or by extrapolation from several previous values. When scheduling requirements are known in advance and precise output is required, coordination between supplier and user will permit a more efficient solution within the engine subroutine iteration.

4.3 Ram Recovery: The engine program will calculate performance when provided with either of the following combinations:

1. Altitude (ALT), free stream Mach number (XM), deviation of ambient temperature from standard (TAMBDT), and one of the following:

   (1) A specified ram recovery standard

   (2) The ratio of engine inlet total pressure to free stream total pressure

   (3) The ratio of engine inlet total pressure to free stream total pressure as a function of airflow and/or free stream Mach number, if applicable.

2. Ambient temperature (TAMB) and pressure (PAMB), inlet/engine interface total pressure (P1) and total temperature (T1), and a temperature increment (T1DT) for inlet heat transfer to be added to T1.

4.4 Distortion: The effects of inlet pressure and temperature distortion (radial, circumferential, and temporal) on the engine will be included in the program when data (or estimates) are available.

4.5 Customer Air Bleed: The engine program will calculate performance when customer air bleed is extracted. The user should be able to input the amount of air extracted from each bleed station as a ratio of bleed flow to the component inlet gas flow from which it is being extracted and/or as a rate. The corresponding output temperatures and pressures will include all engine induced heat transfer and pressure losses up to the bleed port.

4.6 Customer Power Extraction: The engine program will calculate engine performance when power is extracted for customer use.

4.7 Engine Supplied Nozzle Effects

4.7.1 Nozzle parameters used in the calculation of engine performance will be provided as output. These nozzle parameters will include: Nozzle area(s), all gas flows, all engine discharge gas temperatures and pressures, ideal gross thrust, and required airframe supplied nozzle cooling airflow.

4.7.2 When a separate subroutine or supplementary data is needed to define external geometry of an engine supplied nozzle for aircraft performance calculations, the appropriate data will be provided in the program output.

4.8 Engine Anti-Icing: The engine program will have the capability of calculating engine performance when operation involves use of engine anti-icing.

4.9 Windmilling: The engine program will provide, when available, performance output for a limited number of parameters during a deceleration from idle to windmilling conditions. The User's Manual will include the Mach number versus altitude envelope in which windmilling performance is valid.

4.10 Reverse Thrust: If the program supplier provides or has primary responsibility for the performance of an engine thrust reverser or spoiler, then the engine program will calculate this performance over the power range mutually agreed between the program supplier and user. The flight envelope, engine limits, or any other specific limitations on the use of this capability will be defined in the User's Manual.

4.11 Variable Geometry: If the engine represented by the program incorporates variable geometry features that can be rescheduled at the user's option to optimize total system performance, then physical and functional description of this variable geometry will be included in the User's Manual. Also, the engine program output will include definition of the position of the variable geometry for which the performance is calculated. If the user has the option to reschedule the variable geometry without consulting the program supplier, then a description of the method of input and the permissible variation will be included in the User's Manual. This would not normally include trim procedures used on production engines.

4.12 User Supplied Programs: The engine program, when used as a subroutine, must be capable of interfacing with a user supplied inlet program. Other interfaces may be incorporated allowing for such features as ejector intake for an engine supplied nozzle, secondary nozzles for boundary layer control, ejector flaps, and vertical/short take-off and landing stability control.

The methods of operation of the user supplied program and the engine subroutine must be closely coordinated to allow for interaction between them. The program user should, therefore, provide to the program supplier documentation describing his intended usage of the interface items.

4.13 Engine Stability: The engine program will provide indications of the appropriate component stability (e.g. compressor surge margin, burner blow-out). The definitions of stability parameters will be provided in the User's Manual.

5. INPUT/OUTPUT

5.1 Program Interface Definition

5.1.1 The communication between the calling program (written by either the program supplier or user) and the engine subroutine will be handled completely by six labeled commons. The CALL statement to the engine subroutine will contain no arguments. The six labeled commons will be FIXIN (Fixed Input), VARIN (Variable Input), EXPIN (Expanded Input), FIXOUT (Fixed Output), VAROUT (Variable Output) and EXPOUT (Expanded Output). The engine subroutine should never store computed values in FIXIN, VARIN or EXPIN.

5.1.2 The fixed input parameters placed in labeled common FIXIN will be limited to the order and quantity defined in Paragraph 5.2. The fixed output (FIXOUT) will be limited to the order and quantity of parameters defined in Paragraph 5.3. The remaining required input and output will be dependent on engine configuration and contained in labeled commons VARIN and VAROUT, respectively. Labeled commons EXPIN and EXPOUT will be reserved for additional parameters available through coordination between the program supplier and user.

5.1.3 The Input and Output parameter lists in Paragraph 5.2 and 5.3 are consistent with, and in the same order as, the respective Input and Output lists in ARP 681. The parameters unique to Transient Engine Performance Programs are given, in alphabetical order, at the end of each list. Where a steady state performance parameter is not used in the transient program, that position in the parameter list is left blank.

5.2 <u>Input</u>: The fixed sequence list of the parameters that will be included in the fixed input labeled common (FIXIN), and the names that will be used to identify these parameters, are as follows. All parameters are real, floating point numbers, except as indicated.

1.	NIN	Input file number (INTEGER)
2.	NOUT	Output file number (INTEGER)
3.	IND	Engine program indicator (INTEGER)
4.	TITLE (18)	User title dimension 18 (HOLLERITH)
5.	CASE	Numerical case identification
6.	ALT	Pressure altitude - geopotential
7.	TAMBDT	Ambient temperature minus standard atmosphere temperature
8.	T1DT	Temperature increment to be added to T1
9.	ETAR	Ram recovery
10.	HPX	Customer high pressure rotor power extraction
11.	PAMB	Ambient pressure
12.	PC	Power code
13.	PLA	Power lever angle
14.	P1	Engine inlet total pressure
15.		Intentionally Blank
16.	SETAR	Ram recovery selection SETAR = 1. Selects military specification ram recovery SETAR = 2. Selects input value of ETAR SETAR = 3. Selects ETAR as a function of airflow and/or Mach number
17.	SIM	Inlet mode selection SIM = 1. Selects altitude and Mach number SIM = 2. Selects temperature and pressure

18.	TAMB	Ambient temperature
19.	T1	Engine inlet total temperature
20.	WB3	High pressure compressor discharge bleed flow rate
21.	WB3Q_*	High pressure compressor bleed flow ratio (discharge over component inlet)
22.	XM	Free stream Mach number
23.	DIST1	
24.	DIST2	
25.	DIST3	Inlet pressure or temperature distortion
26.	DIST4	parameters (to be defined in User's Manual)
27.	DIST5	
28.	DIST6	
29.	DISTS	Inlet pressure and temperature distortion switch
30.	FMAXP	Primary maximum response frequency
31.	FMAXS	Secondary maximum response frequency
32.	SHP	Power turbine output shaft power
33.	TIME	Time from start of transient case
34.	TIMEF1	Secondary response frequency initiation time
35.	TIMEF2	Secondary response frequency termination time
36.	TIMEP	Print time interval
37.	TIMET	Termination time
38.	XJPTL	Effective polar moment of inertia of power turbine load
39.	XNPT	Power turbine output shaft speed
40.	TRQ	Power turbine output shaft torque

*The number representing the station designation of the relevant component inlet (e.g. 21, 2A) will be defined by the program supplier.

5.3 Output

5.3.1 Parameters: The fixed sequence list of the parameters that will be included in the fixed output labeled common (FIXOUT), and the names that will be used to identify these parameters, are as follows. All parameters are real, floating point numbers, except as indicated.

1.	CLASS (6)	Engine program security classification - dimension 6 (HOLLERITH)
2.	IDENT (36)	Engine program titles - dimension 36 (HOLLERITH)

3.	NSI (10)	Numerical status indicator - dimension 10 (First 9 and last 1) (INTEGER)
4.	AE8	Primary exhaust nozzle throat effective area
5.	AE18	Bypass exhaust nozzle throat effective area
6.	BTANG	Boattail angle
7.	FD	Ram drag
8.	FG	Gross thrust
9.	FGI	Ideal gross thrust
10.	FG19	Gross thrust (bypass stream)
11.	FGI19	Ideal gross thrust (bypass stream)
12.	FHV	Fuel heating value
13.	FN	Net thrust
14.	PB3	High pressure compressor discharge bleed flow total pressure
15.	P7	Primary exhaust flow total pressure
16.	P17	Bypass exhaust flow total pressure
17.	SFC	Specific fuel consumption
18.		Intentionally blank
19.	TB3	High pressure compressor discharge bleed flow total temperature
20.	TC	Cockpit display temperature
21.	T7	Primary exhaust flow total temperature
22.	T17	Bypass exhaust flow total temperature
23.	WFE	Engine fuel flow rate
24.	WFT	Total fuel flow rate
25.	W1	Engine inlet flow rate
26.	W7	Primary exhaust flow rate
27.	W17	Bypass exhaust flow rate
28.	W2*	High pressure compressor inlet flow rate
29.	XNH	High pressure compressor rotor speed
30.	XNI	Intermediate pressure compressor rotor speed
31.	XNL	Low pressure compressor rotor speed
32.		Intentionally blank

33.	ZALT	Pressure altitude used in computation
34.	ZETAR	Ram recovery used in computation
35.	ZPAMB	Ambient pressure used in computation
36.	ZPLA	Power lever angle used in computation
37.	ZP1	Engine inlet total pressure used in computation
38.	ZTAMB	Ambient temperature used in computation
39.	ZT1	Engine inlet total temperature used in computation
40.		Intentionally blank
41.	SML	Low pressure compressor stability margin
42.	SMI	Intermediate pressure compressor stability margin
43.	SMH	High pressure compressor stability margin
44.	ZM	Free stream Mach number used in the computation
45.	ZNPT	Power turbine output shaft speed
46.	ZSHP	Power turbine output shaft power
47.	ZTIME	Output time
48.	ZTRQ	Power turbine output shaft torque

*The full number representing the relevant station designation (e.g. 21, 215, 2A) will be defined by the program supplier.

5.3.2 Printout: In addition to the output parameters in labeled commons FIXOUT, VAROUT and EXPOUT, the output printout will include all input parameters (FIXIN, VARIN and EXPIN). All printout will be under the control of the calling program.

5.4 Units: Input and output parameter values will be based on the pound, foot system of measurement commonly used in the United States. However, the SI (metric) units are an acceptable alternate.

Appendix C defines the units that will be used for either system.

5.5 Numerical Status Indicators (NSI)

5.5.1 Numerical Status Indicators will be used, where applicable, to notify the program user of any limits or qualifications of the output data. The Numerical Status Indicator codes defined in Paragraph 5.5.2 will be used. The program supplier also may elect to print the actual words of the message in the output.

5.5.2 A four digit number will be used as the message indicator. The first digit will indicate the quality of the output, as defined in Table 1. The second digit will indicate the nature of the problem affecting the output, as defined in Table 2. The third and fourth digits will indicate specific messages that will be defined in the User's Manual. Ten Numerical Status Indicators (first nine and last one) will be available for output during the initial condition calculations. During transient operation, at least one Numerical Status Indicator shall be provided in the output. Additional Numerical Status Indicators may be obtained as mutually agreed upon between supplier and user. If an invalid output Numerical Status Indicator occurs, the transient should be terminated and the value of time (ZTIME) at which failure occurred should be returned.

TABLE 1

NSI	First Digit, Quality Indicators
0000	All output valid, no errors, no limits exceeded
0XXX	Input reset to limit, output valid as specified
1XXX	Limit exceeded, output provided for interpolation only
2XXX to 8XXX	Ope. for suppliers use with definitions supplied in the User's Manual
9XXX	Output not valid

TABLE 2

NSI	Second Digit, Category Indicators
X1XX	Computing problems (e.g. fails to converge, job in loop, failure unknown)
X2XX	Input problems (e.g. missing input, wrong order)
X3XX	Rating or power problems (e.g. thrust requested above or below engine capability)
X4XX	Installation problems (e.g. bleed flow pressure or percentage exceeded, power extraction exceeded, secondary flow limit exceeded, distortion limit exceeded, etc.)
X5XX	Envelope problems (e.g. engine structural limit exceeded, Mach limit exceeded, temperature limit exceeded, etc.)
X6XX	Stability problems (e.g. surge, burner blow-out)
X7XX to X9XX	See User's Manual

6. PROGRAM IDENTIFICATION

6.1 Every engine program will have a unique identification and date. Provision will be made to print out this identification on each set of output.

6.2 Every tape transmitted will be uniquely, externally marked to show:

1. Number of channels (7 or 9)
2. Density (556, 800, 1600 bits per inch)
3. Blocking factor, record length, record format
4. Engine name and/or program identification
5. Recording mode (character code, odd or even parity, internal or external machine code)

6. Program originator

7. Number of files and their identification

8. Whether or not the tape is labeled

9. Inter-record gap length

6.3 Every card deck transmitted will be uniquely labeled with program supplier name, engine name and/or program identification and numerically sequenced where possible. Any special operating system control cards will be included.

7. PROGRAM CHECKOUT

Program checkout will be accomplished with the independent program as supplied. Input for test cases will be included with the engine program along with corresponding output for sufficient cases to demonstrate all engine program input options described in the User's manual. Coordination of these program test cases between user and supplier is particularly important in transient programs since excessive testing can lead to increased cost of verifying the test cases.

8. PROGRAM REVISIONS

8.1 The nature of, and reason for, changes or revisions to computer programs will be documented by the program supplier when the revision is submitted to the user. The User's Manual or program operating instructions will be kept current with the revision.

8.2 When revisions are made they will be identified by a logical change to the basic program identification number with a corresponding revision date. Documentation which refers to the program will include revision designations when practicable. Revision designations will be included on the printout.

8.3 Programs revised by the user without written consent of the supplier will be the responsibility of the user.

9. OPTIONAL FEATURES

Transient engine performance programs will contain optional features and capabilities to the extent agreed upon between the program supplier and user. The intent of such optional features will be to facilitate the calculation of all essential aspects of engine transient performance.

Examples of these features are:

1. Operation under certain engine failure modes

2. Increased stability margin operation

3. Starting or Shutdown: Under some circumstances the transient engine performance program will be used to simulate starting or shutdown conditions. However, the special nature of these conditions usually dictates the creation of a specific type of transient program.

10. REFERENCE DOCUMENTS

The following documents shall form a part of this recommended practice:

1. American National Standards Institute, ANSI X3.9, FORTRAN

2. U.S. Committee on Extension to the Standard Atmosphere, U.S. Standard Atmosphere, 1962.

3. S.A.E., Gas Turbine Engine Steady State Performance Presentation for Digital Computer Programs, ARP 681.

4. S.A.E., Gas Turbine Engine Status Performance Presentation for Digital Computer Programs, ARP 1211.

5. International Organization for Standardization, International Standard Atmosphere (Draft 1971, Issue Pending), ISO 2533.

PREPARED BY

SUBCOMMITTEE S-15A, GAS TURBINE ENGINE TRANSIENT PERFORMANCE PRESENTATION FOR DIGITAL COMPUTER PROGRAMS, of SAE COMMITTEE S-15, ENGINE PERFORMANCE PRESENTATION FOR ELECTRONIC DIGITAL COMPUTERS